Participatory assessment of local yam cultivars (*D. cayenensis* and *D. rotundata*) in Benin

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Summary

Participatory assessment of local yam cultivars (*D. cayenensis* and *D. rotundata*) in Benin

Guinea yam (*Dioscorea rotundata* Poir. and *Dioscorea cayenensis* Lam.) is a native, old and traditional crop of West Africa. A long history of cultivation combined with high genetic diversity has led to important indigenous knowledge that needs to be documented. In Benin, farmers' expertise in adapting agricultural practices and landraces to local environmental constraints is remarkable. In order to document farmers' knowledge and strategies in managing diversity of yam landraces, a survey was conducted in the whole yam production zone of the country. Seventy villages and 11 major ethnic groups were covered. More than 310 distinct local varieties were recorded. Information was collected using both key-individual interviews and group discussions. Each variety was characterized on the basis of agronomic, post harvest and organoleptic attributes. From the farmers statements it appears that food quality (overall ability to give good pounded yam), yield, earliness, market value, storage ability and seed quality are the major preference criteria. Information gathered will assist the national yam genetic research programme to formulate appropriate strategies for participatory breeding and *in situ on farm* conservation.

Key words: *Dioscorea cayenensis*, *Dioscorea rotundata*, yam, indigenous knowledge, participatory assessment, Benin

Résumé

Évaluation participative de cultivars locaux d'igname (*D. cayenensis* et *D. rotundata*) au Bénin

L'igname de Guinée (*Dioscorea rotundata* Poir. et *Dioscorea cayenensis* Lam.) est une ancienne plante cultivée indigène, traditionnelle d'Afrique occidentale. Une longue pratique de culture ainsi qu'une grande diversité génétique ont abouti à la constitution d'un important savoir local qui doit être consigné. Au Bénin, les agriculteurs possèdent une expérience remarquable dans l'adaptation des pratiques agricoles et des variétés locales aux contraintes de l'environnement. Afin de consigner le savoir des agriculteurs et leurs stratégies dans la gestion de la diversité des races locales d'igname, une étude a été réalisée dans l'ensemble de la zone de production de l'igname du pays. Soixante-dix villages et 11 groupes ethniques majeurs ont été inclus dans cette étude. Plus de 310 variétés locales distinctes ont été enregistrées. Les informations ont été collectées à la fois par des interviews individuelles et des discussions de groupe. Chaque variété a été caractérisée sur la base de critères agronomiques, post-récolte et organoleptiques. À partir des déclarations des agriculteurs, il apparaît que la qualité alimentaire (aptitude globale à donner une igname de qualité optimale), rendement, précocité, valeur marchande, aptitude à la conservation et qualité des semences sont les critères les plus importants. Les informations réunies aideront le programme national de recherche génétique de l'igname à formuler des stratégies appropriées au programme de sélection participative et de conservation *in situ* sur le site de l'exploitation.

Resumen

Evaluación participativa de los cultivares de ñame local (*D. cayenensis* y *D. rotundata*) en Benín

El ñame de Guinea (*Dioscorea rotundata* Poir y *Dioscorea cayenensis* Lam.) es un viejo cultivo tradicional nativo de Africa occidental. La larga historia de su cultivo combinada con su elevada diversidad genética, ha generado un importante acervo de conocimientos indígenas que necesita ser documentado. Es digna de nota la experiencia de los agricultores de Benín para adaptar las prácticas agrícolas y las variedades locales a los inconvenientes del medio ambiente. Para documentar los conocimientos y estrategias aplicados por los agricultores para ordenar la diversidad de las variedades locales de ñame se llevó a cabo un reconocimiento de toda la zona de producción de ñame en el país, que cubrió setenta aldeas y 11 grupos étnicos principales. Se registraron más de 310 variedades locales distintas. La información se recogió mediante entrevistas a individuos clave así como en debates en grupo. Cada variedad se caracterizó sobre la base de sus atributos agronómicos, organolépticos y poscosecha. De las declaraciones de los agricultores resulta que la calidad alimentaria (capacidad general de producir ñames que puedan molerse bien) rendimiento, prontitud, valor de mercado, disposición para el almacenamiento y calidad de la semillas son los principales criterios de preferencia. La información reunida servirá para que en el programa nacional de mejoramiento genético del ñame se formulen estrategias apropiadas de mejoramiento participativo y conservación *in situ* en las explotaciones agrícolas.

Introduction

Yam (principally *Dioscorea rotundata* Poir. and *D. cayenensis* Lam.) is a very important food crop in West Africa, especially in the area from Nigeria to Côte d'Ivoire. This region alone produces more than 90% of world production of yam (FAO 2005). In the so-called 'yam belt', which corresponds to the humid savannah zone (see Figure 1), yam is an important food source in rural communities, and is also cultivated for commercial purposes and sold to urban consumers even outside its production zone. In the last forty years, the production of yam has increased at a rate of about 4% per year, and is projected to continue increasing by 3% per year the next twenty years, essentially for direct human consumption (Scott et al. 2000).

This increase is due to the fact that yam remains a prestigious and popular food, even though it is more expensive in urban areas than other starchy foods, such as cassava (Bricas et al. 1997; Attaie et al. 1998; Vernier and Dumont 1998).

Technical improvements generated through scientific research have contributed very little to the expansion in yam production. Cultivation involves very few chemicals, labour is essentially manual, and the cultivated varieties are mainly

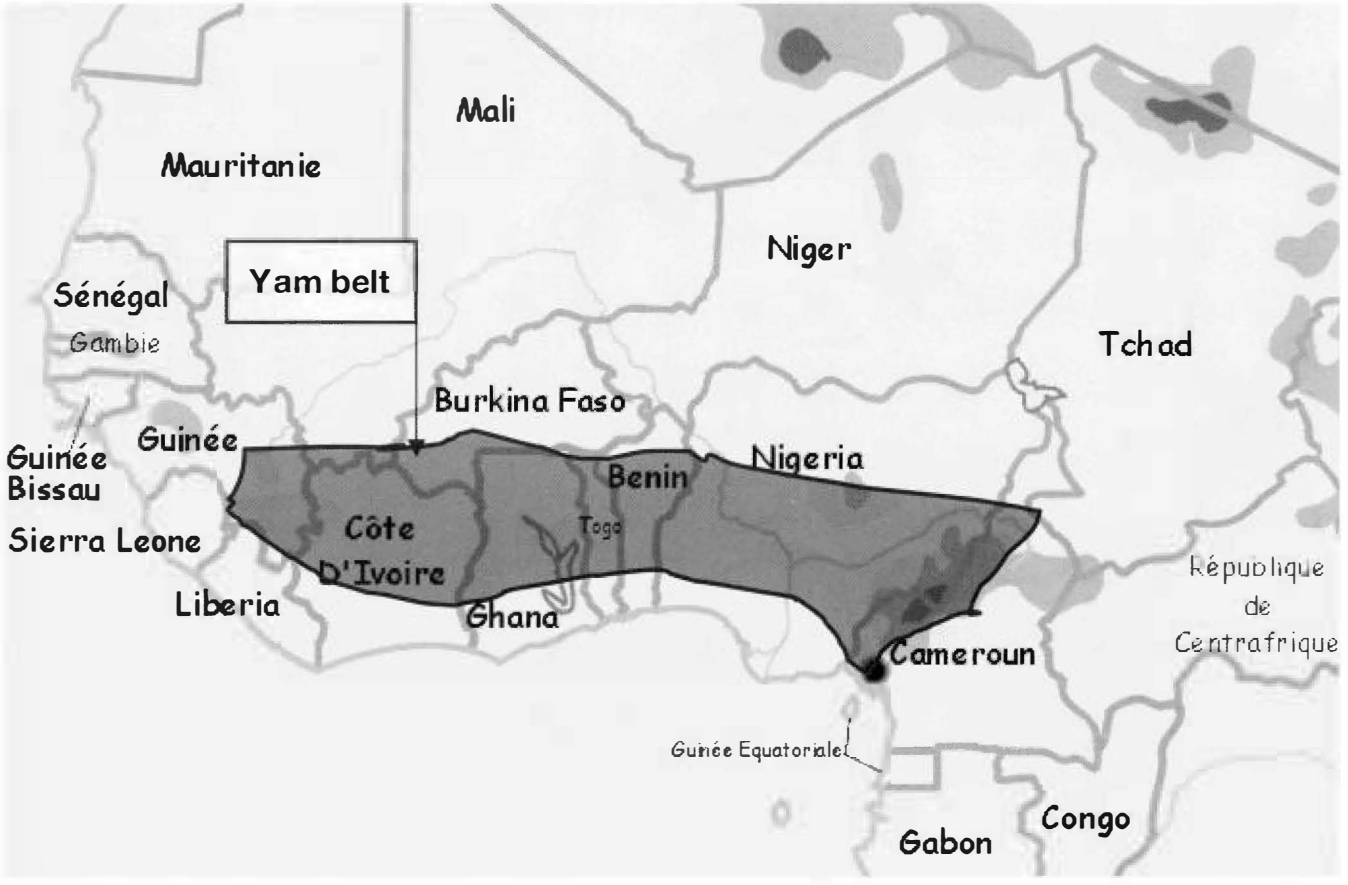

Figure 1. The West African yam belt. Source: Cirad.

landraces. With exception of the cultivar Florido (*D. alata*)—a selection from Puerto Rico introduced to Côte d'Ivoire in the 1970s, and which currently is the basis for almost half the yam production of Côte d'Ivoire (Doumbia et al. 2004) and which continues to expand in the subregion—no bred variety has been adopted to any notable degree by farmers, probably because comparative advantages over traditional varieties are not significant enough.

Several factors explain the poor results from varietal improvement: the genetic complexity of the *Dioscorea* species complex (polyploid, dioecious plants, whose flowering occurs at different periods according to sex), a poor knowledge of the genetic material (which is still insufficiently characterized), and insufficient selection effort, even though promising renewed interest has been evident in recent years (Akoroda 1998).

The increased production is essentially due to expansion of the area cultivated. In the traditional production zones, the area of cultivation has expanded, while in other areas cultivation has extanded into new areas, such as Nigeria, where production areas have been relocated from the rain forest to the Northern savannahs (Manyong et al. 1996), or in Benin, where, in contrast, cultivated areas have moved closer to the coastal regions (Dumont and Vernier 1997).

African farmers have adapted the local plant material to these new environments. These adaptations are the result of their skill and their understanding of their own genetic resources. It is therefore important to take this expertise into account in order to manage regional exchanges of plant material more efficiently and to enhance varietal creation.

The aim of this paper is to present the results of work carried out in Benin, which consisted of collecting and analysing data on farmers' knowledge of traditional yam varieties.

Methodology

A survey was conducted in the main yam growing regions of Benin, with 70 villages, representing 11 major ethnic groups, covered. The geographical distribution of the villages is shown on the map in Figure 2.

The survey consisted of interviews with groups of 5 to 10 yam producers, recognized as having experience in this type of cultivation. It was not possible to interview any women, as, in Benin, yam cultivation is considered a man's business.

The questions were divided into three groups:

- General questions on cultivation techniques.
- Questions relating to early varieties.
- Questions relating to late varieties.

The groups were also asked to give their quality criteria for a maximum of 10 main varieties, using two approaches: in a spontaneous manner for each variety; and through

Figure 2. Sites of villages in Benin surveyed to establish distribution of yam varieties.

paired comparisons of varieties, explaining which criteria contributed to the preference for a given variety.

This methodology was based on that designed for the participatory appraisal survey of maize varieties (Defoer et al. 1997). It made it possible to quantify the criteria according to which the farmers assess local varieties. Paired comparisons facilitated understanding of the hierarchical system adopted by the farmers to classify the different varieties, and to balance their criteria for assessment and varietal choice.

Results and discussion

In all, 313 varieties (named landraces) of *D. rotundata* and *D. cayenensis* were found, some of them being common to several ethnic groups. This overlap explains the difference with the figure found (366) when summarizing the number of cultivars found in each ethnic group (Table 1). They were of two types: early maturing, which was generally harvested twice yearly, and late maturing, harvested once annually. They could be divided into 26 morphobotanical groups, based on identifications in a previous study (Dansi et al. 1999).

The size of the varietal range seemed to be directly linked to the size of the geographical area occupied by each ethnic group: the Bariba had the greatest number of varieties, followed by the Nago and the Fon (Table 1).

Overall, the number of early varieties was similar to that of the late varieties (180 vs 186, respectively), but there were important differences between ethnic groups. The more isolated groups, living in the mountainous areas where agriculture has remained more traditional (Biali, Wama) and less focused on trading, grew more early varieties. In the areas where late varieties represented the majority, the factors given by the farmers to explain their preferences were a higher yield, smaller and more numerous tubers facilitating harvest and the processing into dry chips, and less disease susceptibility. One of the main preference factors was storability.

Lateness in itself did not seem to be an important criterion to the farmers, but the characteristics they were looking for were often, but not always, found in late maturing varieties. Dumont (1997) showed the synergy between cotton production and late maturing yams that could be stored for longer (e.g. Banioure type) and were easy to use by people working in the cotton fields. This contradicts the idea that there was a natural antagonism between these two crops.

Geographical distribution

The map in Figure 3 shows the geographical distribution of the biodiversity. The average number of varieties per village, all types included, varied from 8 to over 40. Overall, the diversity increased along a south-north gradient and was related to the importance of yam in the local agriculture and staple diet. There were two big zones of diversity, the north part and the central part of the country.

Participatory assessment of the varieties

Initially, the farmers spontaneously assessed each of the 10 best varieties in their village. Secondly, they were asked to carry out paired comparisons of these varieties, by indicating which was the one they preferred and the criteria for their choice. The paired comparison made it possible to draw criteria matrices, an example of which is given as Annex 1 [on-line]. A matrix was obtained for each ethnic group and each yam type (early or late maturing).

These two series of assessments are summarized in Table 2 and made it possible to organise the criteria used by the farmers in their varietal choices. The criteria of appreciation were almost the same in both series (open ended and paired comparisons).

Organoleptic quality was the most important criterion, followed by yield. For the first criterion, it was the yam's capacity to give good quality *futu* (pounded yam) that was important. Beninese consumers have a marked preference for this preparation. This quality requirement was slightly more important for early maturing yams, which were consumed almost exclusively pounded, rather than for late maturing yams, which can be prepared in various ways, such as boiled or roasted.

Table 1. Distribution of early and late maturing yam types according to ethnic group.

Ethnic group	Early varieties		Late varieties		Total
	Number	Percentage	Number	Percentage	
Bariba	44	44	55	56	99
Biali / N'bermin	23	77	07	23	30
Fon / Mahi	25	52	23	47	48
Kotokoli /Ani	12	40	18	60	30
Lokpa	5	33	10	67	15
Nago	38	48	41	52	79
Wama	16	62	10	38	26
Yom (Pila-Pila)	17	44	22	56	39
Total	180		186		366

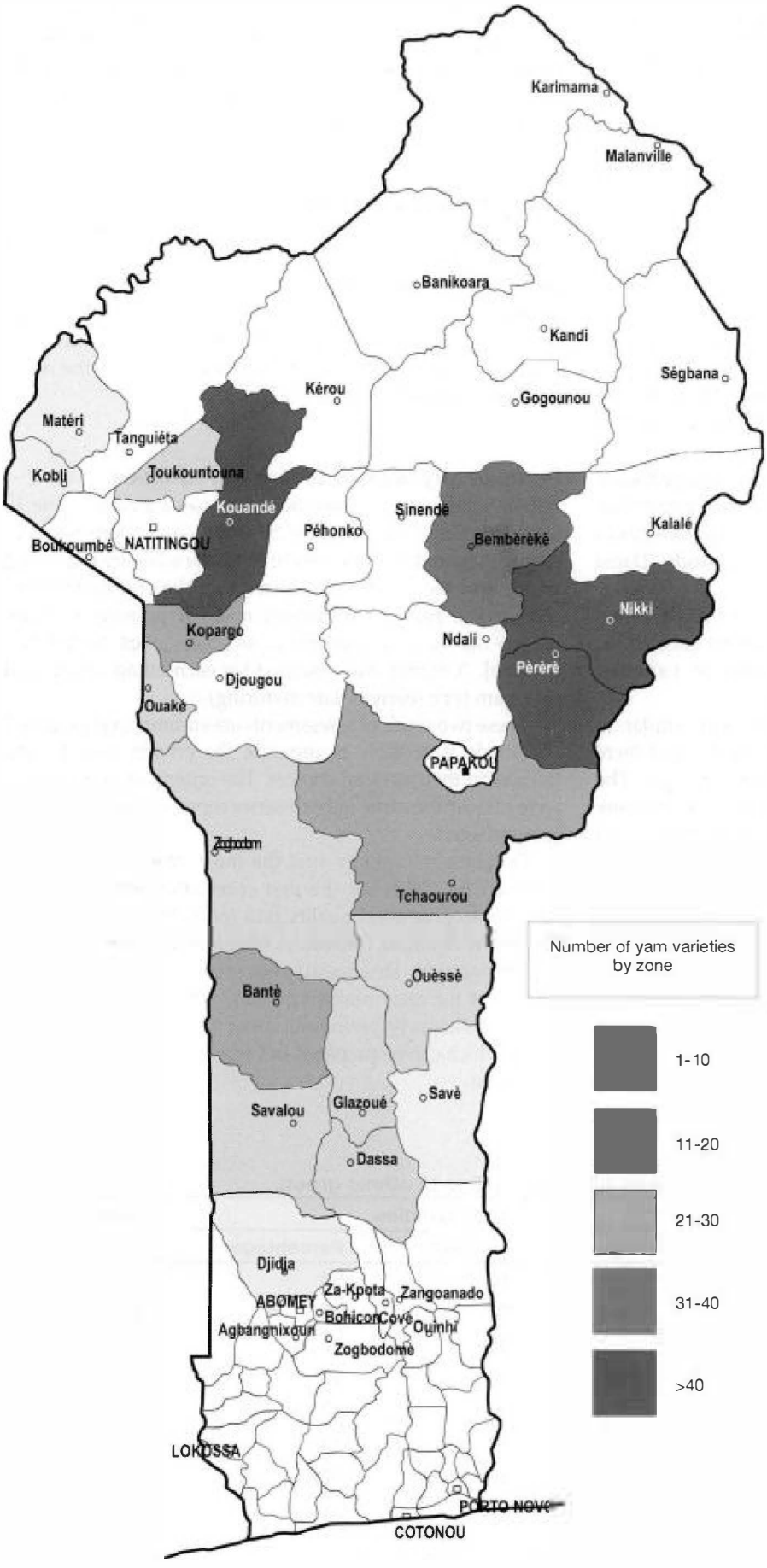

Figure 3. Distribution of yam varieties in Benin.

Table 2. Frequencies of varietal assessment criteria.

	Type of questioning			
	Open-ended		Paired comparison	
Assessment criterion	Early varieties	Late varieties	Early varieties	Late varieties
Organoleptic quality	33	20.3	36.3	30.92
Yield	30.2	31.8	30.1	27.2
Chip quality	0	30.5	0	19.83
Wide adaptability	15.04	0	4.1	4.8
Storage quality	9.2	8.25	6.3	5.25
Earliness	7.2	0	10.3	0
Market value	3.56	3.30	8.1	6.8
Disease resistance	0.3	4.5	2.60	2.9

The second farmer criterion was yield, evaluated by output per plant. Certain criteria only concerned some types of yam.

Earliness was important for the milked (double harvested) varieties. Fast tuberization was sought in order to harvest as early as possible. The aim was to obtain new yams—the most popular and sought after—as quickly as possible for the market. The plants had then be given enough time to yield a second tuberization before the dry season, which tubers would then be used primarily as planting material for the following season. Continuity of production depended on this second tuber production stage.

The quality of dry chips is important for late varieties as they are the only ones used for this transformation. During the dry season, the tubers are peeled, pre-cooked and sun dried. A significant part of the yam produced in Benin is processed in this manner (Bricas et al. 1997).

Adaptability concerns both tolerance to different soils and good seed efficiency, i.e. the success rate of field establishment of seed tubers when planted. This latter criterion is particularly important with early varieties, which explains why they are more demanding in terms of the cultivation environment, in particular because they are planted much earlier and have to sprout and establish before the rainy season becomes stable. The plants rot more easily in less favourable conditions (planting after short fallow periods or maintained in repeated cultivation).

The criterion of disease resistance is seldom mentioned. This reflects the fact that diseases have generally little visible impact in traditional yam crops, where varieties susceptible to disease would be eliminated.

Adaptation of varieties to the constraints of the cropping systems.

The information on their varieties provided by Benin's farmers enabled the authors to select those varieties suited to the various cultivation constraints.

Yam is known to require fertile soils. It is often grown on newly cleared land. In reality, this requirement is variety dependent. Table 3 identifies those varieties that, according to the farmers, have particular fertility requirements.

The farmers identified two groups of varieties. The first group were those varieties that must be cultivated only after a long fallow. These were essentially the early maturing varieties, generally harvested twice a year. The other group could be grown twice on the same plot, and were mostly late varieties.

This confirms and completes the studies of yam farming systems (Vernier et al. 1999) that have shown that the chip-oriented varieties, known as *kokoros*, did well even on plots that have already been cultivated.

In fact the kokoros—late varieties with numerous small tubers—were an important group comprising many cultivars which, according to Dansi et al. (1999), could be divided into ten morphobotanical groups. Within this important group, in Benin, but also in Nigeria and Togo (Vernier et al. 1999), there were differences in performance according to the different cultivars, which the farmers had noticed. Indeed a number of kokoro cultivars were considered, in contrast, to require good soil fertility.

More surprisingly, the farmers identified varieties that appeared to have specific edaphic tolerances as regards gravely soils, on the one hand, and hydromorphic soils in lowland condition on the other (Table 4).

The varieties suitable for gravely soil were essentially late varieties (except for Akpantajo). They belonged to two groups, Banioure and Kokoro, that were known for their hardiness and their adaptability to less fertile soils.

Their adaptability to hydromorphic soils might at first seem surprising, as yam is generally known as a plant that does not withstand hydromorphy very well. In fact, this adaptability is related to the need for early planting, i.e. before rains start, for the varieties that are harvested twice a year. In the regions where rains are likely to start late, these yams are cultivated on high mounds (>1 m) in lowland areas in order to avoid contact with the water-table during the rainy season.

The case of the alakissa varietal group is different. These are Yellow yams (*D. cayenensis*) and have a very long cycle

Table 3. Fertility requirement for some varieties according to farmers' statements.

	Morphobotanic group†	Maturity (L = late; E = early)
Varieties that should be cultivated only after a long-duration fallow		
Agangan, Doundoua	Alakissa	E
Ala n'kodjèhoué, Ouroutanaï	Mondji	E
Ankplomon, Douba yessirou	Douba Yessirou	E
Baridjo	Baridjo	E
Boki	Nonforwou	E
Gnalabo	Gnalabo	L
Kologo, Singou	Kokorogbanou‡	L
Kponan, Laboko	Kponan	E
Maretassou	Antawororou	E
Noualaye	Noualaye	E
Terkokonou	Terkokonou	E
Varieties suitable for cultivation after other crops		
Baniouré	Baniouré	L or E
Brizzi, Yakarango, Youéyouédota	Kokorogbanou‡	L
Kagourou, Tabane	Tabané‡	L
Ourtchoua, Sobasson	Ourtchoua	L
Porchebim	Porchebim‡	L
Sogodo	Marpawa	L

Notes: † According to the classification of Dansi et al (1999). ‡ Belongs to the kokoro-type varietal group.

Table 4. Suitability of some yam varieties to specific soil conditions, according to farmer statements.

	Varietal group	Maturity (L = late; E = early)
Varieties suitable for lowland condition (hydromorphic soil)		
Soagoné, Fagoné	Agogo	E
Yantarororou	Antawororou	E
Ikèni	Alakissa	L
Kponan	Kponan	E
Kratchi	Kratchi	L
Effourou, Youbè, Ewé, Hè-abalo	Mondji	E
Morokorou	Morokorou	E
Dodo	Nonforwou	E
Noualaye, Lafoun	Noualaye	E
Soussou fabou, Soussouka, Taotimanin	Soussou	E
Varieties suitable for gravely soil		
Akpantajo, Wetaman	Ahimon	E
Ouchankoehan	Baniwouré	L
Aloukpa, Awaya, Kologo, Tounonhe	Kokorognanou	L
Ewotolo, Wolouchahabim	Porchebim	L

and a very short dormancy period. They are adapted to the humid forest zone (Orkwor et al, 1998). In the Savannah regions, where the dry seasons are severe, the farmers plant them in the low-lying areas in order to have immediate access to residual soil moisture.

Information on the origin of the varieties

Introductions from neighbouring countries

One of the problems facing the farmers is the replacement of their planting material when they find the performance of some varieties worsening, or even disappearing completely. In

the absence of easy access to improved varieties, introductions are carried out spontaneously from neighbouring regions.

Thus, of 313 different local varieties identified during the survey, 18% originated from elsewhere, mostly Nigeria, a country with a great genetic diversity of yams (Table 5).

Varieties originating from domestication

Another replacement source of plant material available to farmers is domestication of wild yams, which are numerous in their environment. This process, which still needs further study, involves domestication of wild species, principally *D. abyssinica* and *D. praehensilis*. The domestication techniques used by the farmers in Benin have were described by Dumont and Vernier 2000). Although marginal, this practice is known and used more or less actively by all ethnic groups cultivating yam in Benin and in neighbouring Nigeria (Vernier et al. 2003).

The survey reported here found that 38 (>12%) of varieties originated from more-or-less recent domestication (within the last 30 years). They are listed in Annex 2 [online]. This active contemporary domestication process is particularly interesting as it makes it possible for farmers to use the products of sexual breeding. Indeed wild yams come from seed, whereas in agriculture the cultivated forms are multiplied only vegetatively.

Conclusion

Farmer expertise regarding traditional varieties constitutes an important element in the knowledge and management of genetic resources. This is particularly true of Guinea yams (*D. rotundata* and *D. cayenensis*), with their very long tradition of cultivation, to which agronomic research still offers few alternatives. African farmer knowledge in the Yam belt is considerable, and the farmers have shown great ability to adapt to environmental diversity and to socio-economic changes if a wide enough genetic base was available to them (Dumont and Vernier 1997).

In order for any database of farmer knowledge to be used efficiently, it must be based on a sufficiently precise characterization of the plant material. This is the case in Benin, where a complete morphobotanical and molecular characterization of the genetic material of the *Dioscorea cayenensis-rotundata* complex has already been established (Dansi et al. 1998, 1999, 2000a, 2000b). Thanks to this database, a catalogue of traditional varieties will soon be published; it will list all major cultivars with their main characteristics and agronomic potential. This tool will make it possible to manage this plant material better and to target possible international exchanges of varieties with a greater chance of success.

This task of characterization, which is both scientific and participatory, has yet to be completed in most countries of the African yam belt. This is the case in Nigeria, which is by far the largest yam producer and has, with high probability, the widest genetic base, reflecting the nations size.

Table 5. Origin of recorded yam varieties in Benin.

Origin	Number of varieties	Proportion (%)
Benin	257	82
Other countries	56	18
of which Nigeria	47	15
Ghana	6	2
Togo	3	1
Total from all countries	313	100

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Annex 1. Examples of pair comparison matrices for early-maturing and late-maturing yam varieties in Bariba zone, Benin – available on-line from http://www.bioversityinternational.org/publications/pgrnewsletter/default.asp?id_issue=147

Annex 2. List of the 38 recently domesticated yam varieties in Benin found during the survey – available on-line from http://www.bioversityinternational.org/publications/pgrnewsletter/default.asp?id_issue=147

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